Organochlorines in Pacific Walrus

John R. Kucklick, William D. Struntz, Paul R. Becker (NIST), and Geoff York (USGS)
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Abstract

Pacific walrus in Alaska are found along the sea ice edge for most or all of the year. During the brief summer months, females, dependent young and some males migrate North with the receding sea ice through the Bering Straight into the Chuckchi Sea. The remaining males migrate to coastal haulouts along the Alaskan and Chukotkan Bering Sea coasts including Round Island in Bristol Bay. The degree to which walrus, particularly males, use these different habitats is not clear. Samples of walrus blubber were obtained from Alaskan Natives collected during subsistence hunts. Samples were archived in the National Biomonitoring Specimen Bank as part of the Alaska Marine Mammal Tissue Archival Project. Walrus blubber was analyzed for persistent organochlorine pollutants (POPs) to provide concentration data on these animals and to assess the potential for regional differences in levels and patterns of POPs. Samples were analyzed by gas chromatography with electron-capture and mass-spectrometry detection for PCB congeners, chlordane compounds, HCHs, HCB, dieldrin and DDT compounds. Concentrations were low relative to other pinnipeds in this region and appear to have geographical differences. For example total wet mass PCBs ranged from 186 ng/g ± 29.6 ng/g in males from Norton Sound/St. Lawrence Island to 67.2 ng/g (61.5 ng/g – 73.3 ng/g) in males from Round Island. Chlordanes, DDTs, HCHs and dieldrin were also about a factor of two lower in males of Round Island relative to those of Norton Sound/St. Lawrence Island.

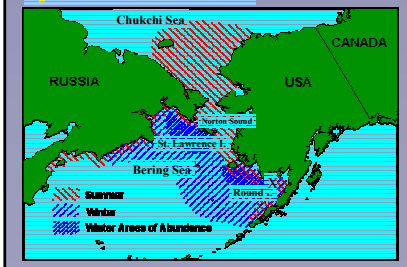
Background

Walrus have a circumpolar distribution in the Arctic and are divided into two subspecies: the Atlantic walrus (*Odobenus rosmarus rosmarus*) and the Pacific walrus (*Odobenus rosmarus divergens*). These two species are geographically isolated, with the Pacific walrus inhabiting the Bering, Chukchi and Laptev Seas, while the Atlantic walrus are distributed from the eastern Canadian Arctic to the Kara Sea. The Laptev Sea population has been proposed as a separate subspecies [Lentfer, 1988].

Pacific walrus exhibit a seasonal migration [Fay et al., 1984]. In the summer, females dependant young, and some mature males travel from their wintering area in the Bering Sea to the Chukchi Sea [Figure 1]. The remaining males summer in the Bering Sea congregating at haulout sites, such as Round Island in Bristol Bay, along the Russian and Alaskan coasts. During the winter, both males and females gather in the north-central and south-eastern Bering Sea [Fay et al., 1984]. There is limited information on the stock structure of the Bering/Chukchi Sea walrus population.

There is also only moderate information on persistent organochlorine pollutants (POPs) concentrations in Pacific walrus [Taylor and Schliebe, 1989] and therefore minimal information for which native communities can use to assess the status of contamination in this important food item. Knowledge of POPs concentrations is also useful for discriminating between groups or stocks of marine mammals, since resident groups often acquire a local POPs signature [Aguilar, 1987]. Walrus generally feed at a low trophic level, primarily on benthic invertebrates, so their POPs concentrations are expected to be low relative to fish-eating marine mammals. However, predation on seals is recognized [Lowry and Fay, 1984], which may lead to elevated levels of POPs in some animals [Muir et al., 1995].

Figure 1: Pacific walrus distribution



Objectives

The goals of this investigation are to

1. Determine POPs concentrations in the Pacific Walrus and compare these levels to the Atlantic walrus.
2. Examine POP distributions in individuals from the Bering/Chukchi population to determine if animals are of one or multiple stocks.
3. Provide Baseline data for the National Biomonitoring Specimen Bank

Materials and Methods

Sampling: Blubber was collected by the U.S. Fish and Wildlife Service and U.S. Geological Survey in collaboration with subsistence hunters using ultra-clean sampling techniques [Becker, et al. 1997]. Tissues were shipped to the National Biomonitoring Specimen Bank where they were stored in liquid nitrogen vapor freezers until further processed.

Analysis: Cryo-homogenized samples were analyzed for POPs as in Figure 2. Analytes were quantified by a five-point calibration curve produced from calibrants that were run through the entire extraction-cleanup scheme. Two aliquots of Standard Reference Material 1945 "Organics in Whale Blubber" were also processed and analyzed with the walrus samples. Lipid was measured gravimetrically in a subsample of the original extract. ΣPCBs is the sum of 33 PCB congeners; Σchlordane is the sum of cis-chlordane, cis- and trans-nonachlor, heptachlor epoxide and oxychlordane, ΣDDT is the sum of 2,4'-and 4,4'- DDT, DDD and DDE. ΣHCH is the sum of α- β- and γ-HCH.

Figure 2: Sample Analysis

Sample	Cryo-homogenized samples were mixed with sodium sulfate
Extraction	Internal standards added then extracted using pressurized fluid extraction with dichloromethane (ASE, Dionex)
Cleanup	Size exclusion chromatography (PLGel, Polymer Labs) followed fractionation using HPLC (aminopropylsilane column, Waters)
Analysis	Capillary gas chromatography with micro-ECD (Hewlett Packard 6890), 60 m DB-5/DB-XLB, 150 minute run time. Oxychlordane quantified by GC-MS-NCI (Hewlett Packard 5973), 30 m HP-5ms.

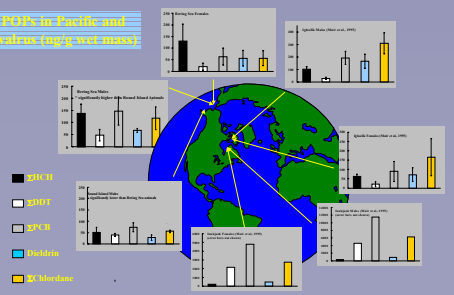
Table 1: Sample Information: NM- not measured

Animal	Age (years)	Sex	Location	Blubber Thickness (cm)
WLRS-016	16 to 25	M	Round Island	6.3
WLRS-017	16 to 25	M	Round Island	NM
WLRS-018	16 to 25	M	Round Island	3.3
WLRS-020	~15	M	Round Island	17
WLRS-001	12 to 15	M	Norton Sound	2.5
WLRS-002	8 to10	M	Norton Sound	2.5
WLRS-003	19	M	Norton Sound	5
WLRS-004	21	M	Norton Sound	3.25
WLRS-005	18	M	Norton Sound	3.0
WLRS-006	8	F	Near St. Lawrence I.	NM
WLRS-007	8 to 10	F	Near St. Lawrence I.	8
WLRS-008	5 to 6	F	Near St. Lawrence I.	6
WLRS-010	Calf	F	Near St. Lawrence I.	NM
WLRS-013	Adult	F	Near St. Lawrence I.	3.9
WLRS-014	6 to 9	F	Near St. Lawrence I.	6.8

Table 2: POPs concentrations in Pacific walrus (ng/g wet mass)

Animal	Lipid (%)	ΣHCH	ΣDDTs	Σchlor	HCB	dieldrin	mirex	ΣPCBs
WLRS-016	74.4	49.3	31.1	70.1	<1.0	22.6	NM	57.9
WLRS-017	62.6	32.8	40.2	71.3	<0.6	32.9	22.7	55.2
WLRS-018	39.7	36.1	41.0	51.9	<1.0	15.5	NM	48.4
WLRS-020	69.0	83.7	47.6	99.6	<0.6	43.0	29.8	62.0
WLRS-001	72.1	175	58.5	190	<1.0	70.7	NM	147
WLRS-002	77.5	108	8.07	90.5	<0.6	53.5	8.3	52.6
WLRS-003	18.8	86.4	45.9	78.3	<0.6	67.0	11.1	92.4
WLRS-004	74.9	162	60.0	181	2.06	75.6	NM	124
WLRS-005	79.2	158	68.3	195	<1.0	71.2	NM	172
WLRS-006	82.0	146	9.40	87.1	<0.6	68.4	6.36	71.9
WLRS-007	81.6	218	9.65	101	<0.6	106	4.39	68.4
WLRS-008	79.4	211	13.8	96.4	<0.6	81.5	8.00	107
WLRS-010	64.3	90.8	8.10	22.8	<0.6	28.3	<1	21.2
WLRS-013	84.5	44.5	43.2	22.8	<0.6	20.6	2.63	22.7
WLRS-014	79.3	69.8	35.7	49.5	<0.6	35.2	10.4	50.4

Figure 3: POPs in Pacific and Atlantic walrus (ng/g wet mass)



Results and Discussion

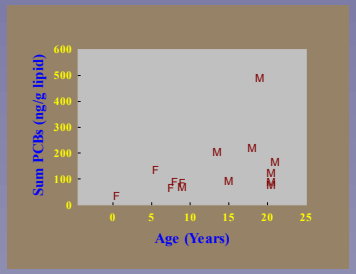
* Concentrations of POPs in Pacific walrus are given in Table 2. Generally, the POPs present in the highest concentrations were the HCHs and chlordanes. Oxychlordane and β-HCH contributed 76% ± 16% and 73% ± 13% to the Σchlordanes and ΣHCHs, respectively. Levels of POPs in the walrus sampled were generally *lower* relative to other marine mammals from this region, such as ringed seals, beluga whales, and bowhead whales [Becker et al., 1997].

* Σchlordanes were significantly lower ($p<0.05$) in the Round Island males relative to male walrus collected from the Bering Sea (Figure 3). Other compound classes were not significantly different in males between the two locations. The patterns of organochlorines were very similar when examined by principal components analysis (data not shown). Therefore, POPs levels and patterns suggests that all the animals sampled are from the same stock.

* Concentrations of POPs in the Pacific walrus were generally in the range of other non-seal eating Atlantic walrus (Figure 3). Levels in POPs in seal-eating walrus [Muir et al., 1995] are much higher than observed for the Pacific walrus.

- There was a weak, non-significant, relationship between age and ΣPCB concentration and generally poor relationships with other POPs (Figure 4). This suggests that the animals are in balance with uptake and depuration of POPs
- The nutritional benefits of consuming traditional foods, such as walrus, far outweigh any known risks.

Figure 4: Age vs. ΣPCB for Pacific walrus



Literature Cited

Aguilar A. (1987) Using organochlorine pollutants to discriminate marine mamal populations: A review and critique of methods. *Marine Mamal Sci.* 3, 242-262.

Becker P. R., Mackey E. A., Demiralp R., Schantz M. M., Koster B. J., and Wise S. A. (1997) Concentrations of chlorinated hydrocarbons and trace elements in marine mammal tissues archived in the U.S. National Biomonitoring Specimen Bank. *Chemosphere* 34, 2067-2098.

Born, E.W., I. Kraul, and T. Kristensen. 1981. Mercury, DDT, and PCB in the Atlantic Walrus (*Odobenus rosmarus rosmarus*) from the Thule District, North Greenland. Arctic. 34(3), 255-260.

Fay, F.H., B.P. Kelly, P.H. Gehnrich, J.L. Sease, and A.A. Hoover. 1984. Modern populations, migrations, demography, trophics, and historical status of the Pacific Walrus. U.S. Dep. Commer, NOAA, OCSEAP Final Rep. 37(1986):231-376.

Fay F. H., Eberhardt L L, Kelly B. P., Burns J. J., and Quakenbush L. T. (1997) Status of the Pacific walrus population, 1950-1989. *Marine Mammal Sci.* 13, 537-565.

Lentfer, J.W. (1988). Selected Marine Mammals of Alaska. Marine Mammal Commission, Washington D.C.

Lowry, L.F. and Hay, F.H. (1984). Seal eating by walrus in the Bering and Chukchi Seas. *Polar Biol.* 3:11-18.

Muir D. C. G., Segstro M. D., Hobson K. A., Ford C. A., Stewart R. E. A., and Olpinski S. (1995) Can seal eating explain elevated levels of PCBs and organochlorine pesticides in walrus blubber from eastern Hudson Bay (Canada)? *Environ. Pollut.* 90, 335-348.

Taylor, D., S. Schliebe, and H. Metsker. 1989. Contaminants in blubber, liver, and kidney tissue of Pacific walruses. Mar. Pollut. Bull. 20(9):465-468.

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